Sediment Dispersal from the Apennine Rivers

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LONG-TERM GOALS

The most general long-term goals of this study, as part of EuroSTRATAFORM, are to investigate the oceanic processes that erode, transport, and deposit sediment in the margin system. More specifically, this project seeks to define and describe the Western Adriatic Current and the Po and Apennine River plumes by direct observations, as well as specially focused experiments to document aspects of dispersal that lead to event layers, bed reworking and cross-margin sediment flux.

OBJECTIVES

The specific objectives of this project are:

1. to document structure of the Western Adriatic Coastal Current and related sediment transport.
2. to document delivery of sediment associated with run-off events.
3. to document cross-margin transport and emplacement of sediment.

APPROACH

To understand the mechanisms of sediment dispersal once delivered to the marine environment, a combination of water column (surface to very near bottom) and bottom boundary layer time-series measurements are necessary. As part of the overall objectives of EuroSTRATAFORM, the work accomplished within the scope of this project is one part of a greater whole. The focus of this work is on water-column observations that complement mooring and bottom boundary layer measurements (Fig. 1). In particular, close collaboration with R. Geyer (WHOI) and B. Mullenbach (formerly WHOI, now at TAMU) has occurred during all phases – field work planning and execution, shared inventory of instrumentation, and data analysis and interpretation now in progress.

The area of interest encompasses the coastal current, the inner shelf influenced by the input from the Po and Apennine Rivers, and the water column overlying the region of sediment accumulation. The observational approach for the water-column studies included repeated hydrographic surveys (CTD, optical measurements for suspended sediments, and water sampling) from the Po River to the Gargano Peninsula (Fig.1) during different river discharge conditions and wind regimes, as well as additional focus on the Apennine shelf in February, maximizing probability of capturing discharge from the flashy Apennine Rivers and Bora wind events (stong winds from the NE). Particular effort was made to document nearbottom, nearshore conditions by using a small CTD/transmissometer/Niskin bottle that measures from the sea surface to 20 cm above the seabed. Hydrographic surveys only provide a

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14. ABSTRACT
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snapshot in time, but the substantial effort to accomplish them in a nearly synoptic way, and repetition of the large-scale survey multiple times during the time-series deployments, provide a large-scale picture of mean conditions as well as a measure of variability under different forcing. This should prove to be particularly valuable for comparing with model hindcasting.

WORK COMPLETED

Through the combined effort with Geyer, Mullenbach, and Italian colleagues, we completed five large-scale hydrographic surveys between November 2002 and May 2003. We were fortunate to charter the Italian Research Vessel *Dallaporta* (Istituto Marine, ISMAR-CNR, Ancona) for one of these large scale surveys, and repeated transect lines off the Apennine margin in Feb 2003. Although field time was limited by weather, the *Dallaporta* surveys proved to be immensely valuable because they captured the closest conditions to a Bora event, as well as transitional periods (pre- and post-Bora) to serve as comparison to other, more quiescent time periods. The water column data are currently being analyzed to compare water column and suspended sediment characteristics under different forcing conditions. These will be combined with modeling efforts and time-series observations to provide quantitative assessment of spatial and temporal variability of the Coastal Current transport.

RESULTS

In general, the large-scale surveys showed that the freshwater signal from the Po River is relatively weak by the time it reaches the Apennine margin with lower salinities confined to the innermost stations of the shore-normal transects, although changes in stratification were observed for varying wind conditions. Precipitation in the Apennine region is highly variable over short spatial scales, and although a high discharge event on several of the Apennine Rivers occurred a week before sampling from the *Dallaporta*, a distinct surface plume with freshwater and sediment signal was only observed at the shallowest stations in total water depths less than 10 m.

Repeated transects seaward of individual Apennine Rivers define variability of cross-shelf extent of the coastal current, significant changes in the width of the front, vertical stratification, and suspended sediment inventory over periods of a few days. Most of the Apennine transects showed suspended-sediment concentrations highest in shallow water, decreasing seaward, and without a distinct bottom boundary layer. The exceptions are associated with the observed Bora event. Example transects from the *Dallaporta* surveys are presented in Figure 2. The first and third panels (Chienti and Pescara, respectively) represent a period following significant freshwater input from the Apennine Rivers. The nearshore is relatively well-mixed, although there is the suggestion of a lower density plume at the surface, but suspended-sediment concentrations are relatively low and confined to the shallower stations. The second and fourth panels immediately follow a Bora event. In the case of the Chienti, suspended-sediment concentrations are much higher, the coastal current extends farther across the shelf, and the integrated suspended-sediment inventory is higher by 50%. In this example, the highest suspended sediment inventories are not at the shallowest station, but at ~15m depth, just shoreward of the maximum cross-shelf salinity gradient, suggesting the high concentrations associated with resuspension events may be bounded by the location of the front. In addition, off the Pescara there is a distinct bottom-boundary layer associated with higher suspended sediment concentrations. Time-series measurements at 12 m depth on the Pescara line (Ogston, UW) show no evidence of significant cross-shelf transport, however measurements at 20 m do show significant off-shelf transport (Puig, CSIC). The detailed cross-shelf surveys, combined with the time-series measurements, as well as model

results, should help to resolve the transition from alongshore advective sediment transport in the northern part of the Apennine margin (i.e. off the Chienti), to the cross-shelf transport to the depocenter adjacent to the Gargano Peninsula.

IMPACT/APPLICATIONS

Focusing effort on water-column measurements provides spatial information to link tripod time-series measurements, provides ground-truthing to satellite and shipboard optical measurements of turbidity, and a means of relating nearbed, bottom-boundary layer processes to the overlying water column. The sum of these observations provides the means to assess mechanisms for sediment dispersal and formation of strata.

TRANSITIONS

See Related Projects below.

RELATED PROJECTS

The water column work described here is an integral part of the Sediment Transport and Strata Formation work in progress by Geyer and Traykovski (WHOI). Collaboration is in progress with water column measurements by Ogston and Fain (UW) who carried out water column sampling that augments the hydrographic surveys in time and space. In addition, work is underway to combine repeated hydrographic sections with time series boundary layer measurements off the Chienti (Sherwood, USGS) and the Pescara (Ogston, UW; Puig, CSIC).

Sediment Trapping and Transport in Estuaries, Southeastern US, National Science Foundation CAREER Development Program, Kineke PI. This project began in September 1997 and is investigating sediment transport and trapping mechanisms in three estuaries in the southeastern United States.

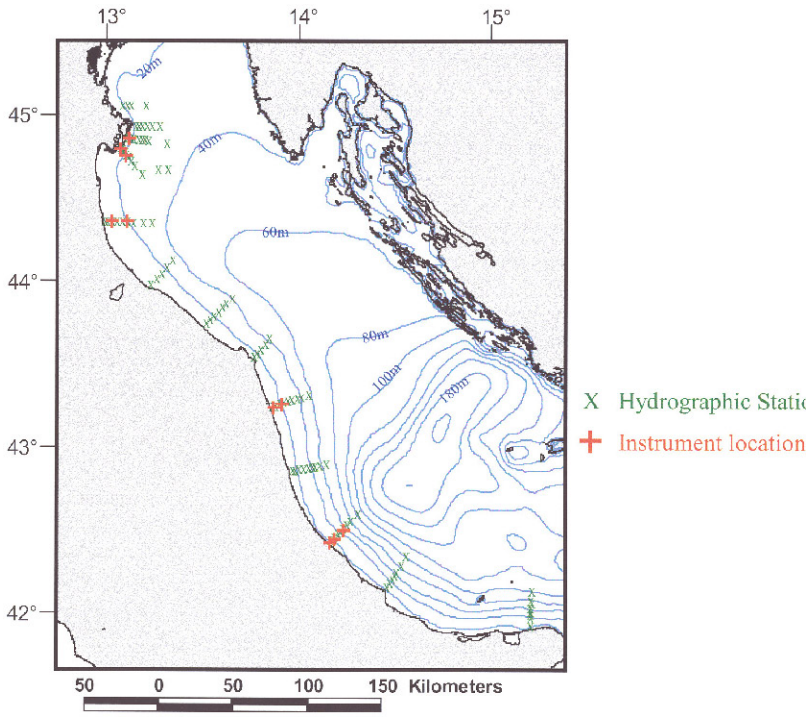

Figure 1. Map of the Northern Adriatic. Contours are in meters. The large-scale hydgrographic stations are indicated by the green symbols and the locations of bottom boundary layer tripods and moorings are indicated by the red symbols. [The hydrographic stations are in a series of shore-normal transects distributed between the Gargano Peninsula and the Po River.]

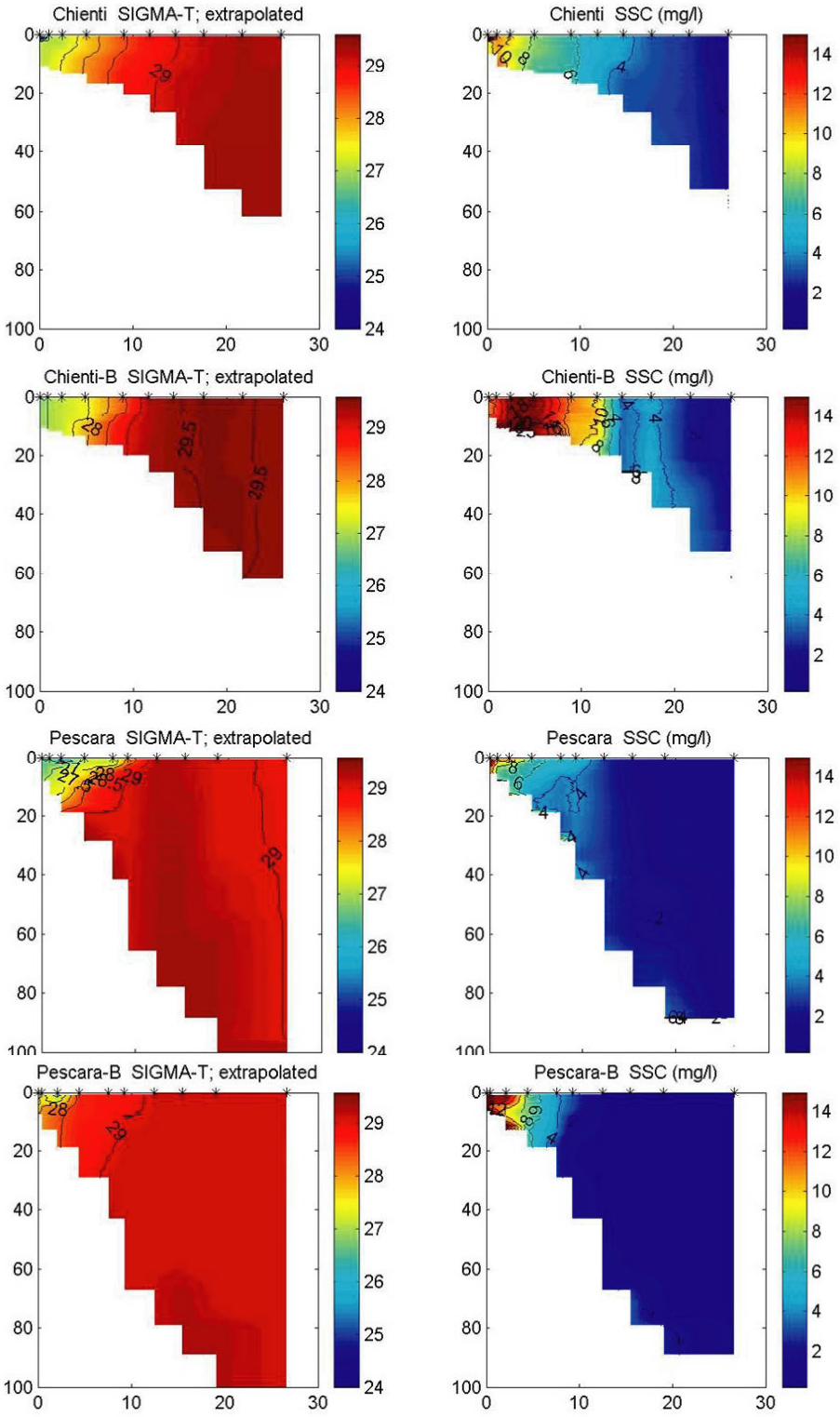

Fig.2 Density (sigma-t) and Suspended Sediment Concentration transects off Apennine Rivers. The top two panels are normal to shore, seaward of the Chienti River mouth, taken on Feb 14 and 19, 2003. Bottom two panels are off the Pescara River, on Feb 14 and 20, 2003. The 1st and 3rd panels follow a period of significant freshwater input, and the 2nd and 4th panels immediately follow a Bora wind event with diminishing wind speed. [Panels 2 and 4 show much higher suspended sediment concentrations extending farther offshore.]